Space Weather Technical Forecast

Issued on Monday, 08 May 2023 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further R1-R2 Radio Blackouts likely. Low confidence CME arrivals day 1 (8th May) bring a likelihood of G1-G2 Minor/Moderate storms, with a chance of G3/Strong Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with the largest flare a long duration event peaking at M1.64 at 07/2323 UTC from AR3293. This was the only M-flare through the period. There are a trio of spot groups spanning the northeast to northwest centre disc, namely AR3293, AR3296 and AR3297. AR3296 is the most interesting as an anti-Hale cycle region (reverse polarity) although this region has declined a little. AR3297 has lost its delta configuration and simplified a little. AR3293 remains magnetically complex. The four regions in the southern hemisphere (including two unnumbered) remain small, weak and stable. Multiple CMEs were observed on the 06 May, however analysis shows no Earth directed components. It's possible a CME has left the Sun associated with the M-flare, further analysis will take place as imagery becomes available.

Solar Wind / Geomagnetic Activity: The solar wind has remained slightly-elevated between 400 and 500 km/s. It is possible that a CME from the 4th May arrived at Earth around 07/1500 UTC. Though the response in solar-wind parameters, and Earth magnetometers, was unremarkable. There is also a possibility that a High Speed Stream from CH01/+ was embedded in the solar-wind. Density was average until a rise to above average was observed after 07/0700 UTC. The peak values approached 40 ppcc between 07/1300 UTC and 07/1445 UTC. Density eased thereafter but remained mostly above average. Total IMF strength, Bt, was initially weak before increasing to Moderate to Strong, reaching a peak of 20 nT around 07/1500 UTC. After-which the Bt eased but remained mostly Moderate. The north-south, Bz, component was mostly neutral or positive between -9 nT and +15 nT. Phi angle was mainly positive (away from the Sun) though it did rotate into the negative orientation for a while after 07/1900 UTC. Geomagnetic activity was Quiet to Unsettled (Kp2-3) with an isolated Active interval (Kp4) 07/1500-07/1800 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, was also at background levels. The 24-hour integrated fluence was at Active levels, but dropped below by 06/1800UTC. At 08/0000 UTC 1.53e6 integrated pfu was recorded.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Further Moderate activity is likely through the next four days, mainly from the regions in the north of the disc.

Solar Wind / Geomagnetic Activity: Of the two CMEs which left the Sun on 4th and 5th May respectively, one may have arrived around 07/1500 UTC with the second possibly still to arrive. So the risk of geomagnetic activity effects extend into day 1 (8th May). Confidence is low with their speeds, and how much material will be within them, giving a low confidence to the geomagnetic forecast. Otherwise current slightly elevated solar winds are expected to gradually ease through the period, once any CME influence has passed. If we see the second CME arrival early on day 1 this is likely to bring a spell of G1-G2 Minor to Moderate storms, with a chance of G3 Strong storms. This risk recedes later day 1 (8th May) with activity becoming mainly Quiet to Unsettled. It's possible that high speed stream influences from positive coronal hole CH02 may arrive at Earth late on day 4 (11th May) though persistence suggests impacts are likely to be weak.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to persist at background with no solar radiation storms occurring. High energy (greater than 2MeV) electron flux is expected to persist at background levels, perhaps rising to Moderate, potentially High later day 3 or day 4 (10th or 11th May). The associated 24 hour fluence is forecast to persist below the Active threshold.

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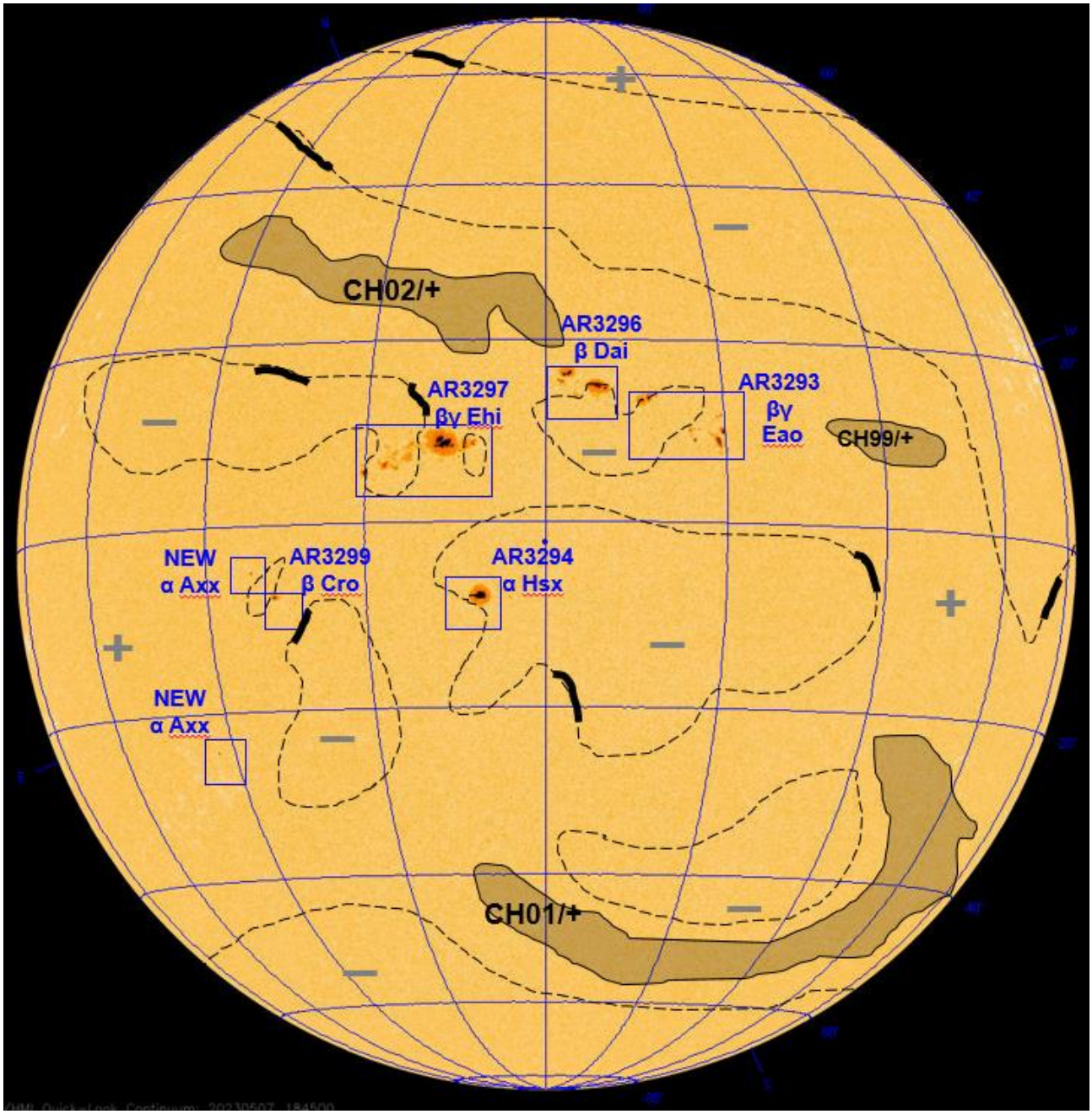
Figure 1. Solar Analysis Valid 07/1900 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The first CME from the 4th of May (associated with an M3.9 flare from AR3296) may have arrived around 07/1500 UTC. Responses at L1 and Earth magnetometers were unremarkable. This was a complex eruption with the main ejecta to the east, behind Earth, but also a full halo shock observed. A further CME from the 5th May may still arrive early on Day 1 (8th May). This was another complex eruption that likely originates from an M2.1 flare of AR3296. This occurred very soon after a C9-flare from AR3297, and is complicated further by a nearby limb E-limb CME that occurred previously. This also has an eastward ejecta component visible, and a clear Earth-directed halo shock.

Influence from any further CME arrivals will extend through much of day 1 (8th May) before easing later in the UTC day. There are a number of sources of uncertainty. This includes the potential for the second CME to miss Earth and for very little impact to occur if only shock is observed, rather than any ejected plasma. Current ACE EPAM data is elevated suggestive of an approaching CME. Otherwise, any influence from the HSS of CH99 is expected to gradually ease away, with winds easing to background day 2 and day 3 (9th and 10th May) as any CME enhancement subsides. Some enhancement in the solar-wind may occur late on day 4 (11th May) due to CH02/+ currently approaching the meridian in the northeast. Any impacts are expected to be weak based on persistence. If we see the second CME arrival early on day 1 this is likely to bring a spell of G1-G2 Minor to Moderate storms, with a chance of G3 Strong storms. This risk recedes later day 1 (8th May) with activity becoming mainly Quiet to Unsettled.

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Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	10	1	5
Strong	G3	No	20	1	1	1
Severe	G4	No	2	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
05/1117	Full	AR3296 M2 or AR3297 C9	NE	950km/s	8th May early	Low confidence

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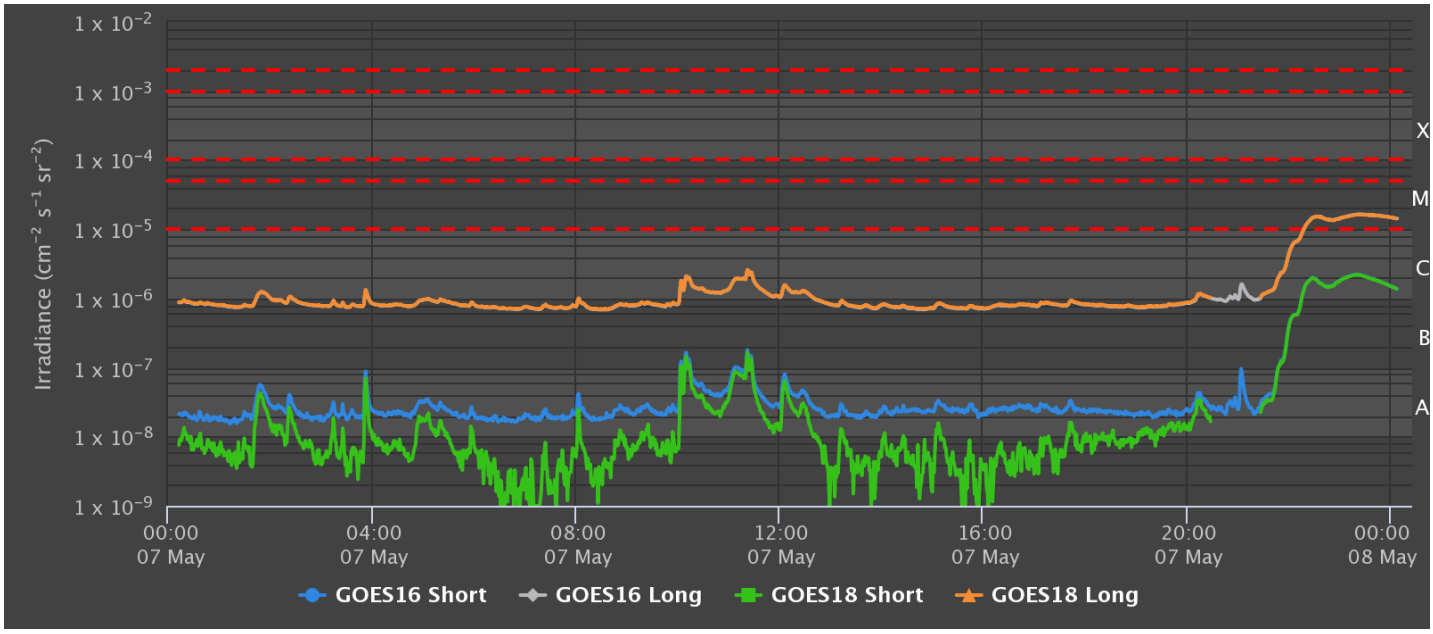
Radio Blackouts - X-Ray Flares:
Occasional Moderate activity is expected to continue, with further M-flares likely.
These are most likely from the three magnetically interconnected sunspot regions across the northern disc. These sunspots have been on a maturing trend with AR3293 furthest west responsible for the M flare.
AR3297 appears to have simplified a little losing its delta configuration. AR3299 has decreased in size. AR3293 remains Eao/Beta-gamma. AR3296, the anti-Hale cycle (reverse polarity) region, has also seen some small spots emerge to the south of it, but the main spots remain small and slowly declining. The other three spots on the disc remain smaller, simpler and stable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 2: GOES16 X-Ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux as observed by GOES-16 is expected to persist at background levels. However, there is a slight chance that count rates may increase with the potential for Moderate flares from the three main sunspot regions across the northern solar disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

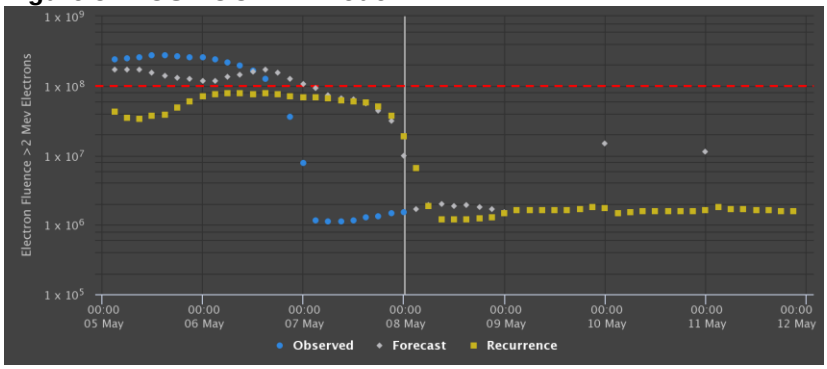
High Energy Electrons Event (≥ 2MeV):

The electron forecast is of particularly low confidence, especially beyond day 1 (8th May) as it will be dependent upon the arrival of CMEs, which have a large amount of uncertainty on them. High energy electron flux (greater than 2MeV) observed by GOES- is at background, and is expected to largely persist at this level through day 1 and 2 (8th-09th May) due to the possibility of further CME arrivals. As the geospace environment eases on day 3 and into day 4 (10th-11th May), electron count rates at GEO have the potential to rise again. This may allow diurnal peak to reach Moderate levels, with a chance of reaching High.

The associated 24 hour fluence remains well below the active level and is expected to persist at this level during days 1 and 2, with only a chance of rising again by the end of day 3 (10th May). REFM is likely to be unreliable in the forecast period due to arrival of CMEs.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	20	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: MOSWOC REF Model



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